Implications of data-sharing for contractual and relational governance in public-private partnerships

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Abstract

Advances in digital technologies, such as smart sensors, force public and private organisations to develop their information processing capabilities. Outsourcing increases organisations' dependence on partners for information required for decision-making, making inter-organisational governance (i.e. contractual and relational mechanisms) an important lever for organisational information processing. We theoretically ground and empirically validate how inter-organisational governance helps to address information asymmetry that arises when capturing information using digital technologies. Using Organisational Information Processing Theory as our theoretical lens, we conduct four in-depth cases in the Dutch infrastructure sector. We provide evidence on the importance of fit between information processing requirements and governance mechanisms employed.

Keywords: Data-sharing, buyer-supplier relationships, case research

Introduction

In General Management studies, and Operations and Supply Chain Management (OSCM) specifically, information technology has long been regarded as an important enabler of information and process integration within organisations and across supply chain actors alike (Ivanov et al., 2019; Kache & Seuring, 2017). The emergence of ICT-based disruptive technologies, such as big data (analytics) and smart sensors, digitally transform supply chains (i.e. Industry 4.0; Harris et al., 2015). Such technologies are often characterised as changing the bases of competition by changing the performance metrics along which organisations compete (Danneels, 2004).

This development affects both public and private sector organisations. In public-private collaborations, which emerge when a public body leverages a private partner's resources and competencies for the purpose of public sector management (Caldwell et al., 2017), disruptive technologies are not yet adopted at a large scale (Van de Kerkhof et al., 2018). Where such technologies have been adopted, disparate data collection and analyses at both the public body and its private-sector suppliers may result in information

asymmetry between them. Information sharing would address this asymmetry, but is usually difficult to organise because of misaligned goals, incentives and organisational practices. The effective deployment of contractual and/or relational governance mechanisms is thus required to coordinate collaboration more generally (Rangan et al., 2006), and information processing activities at both organisations in particular.

A consideration of the roles that contractual and relational governance mechanisms play in addressing information asymmetries during the implementation of disruptive technologies in inter-organisational relationships (IORs) addresses several gaps in prior governance and technology transformation literatures. First, while prior work argues that the implementation of digital technologies results in huge increases in technical and commercial information (e.g. Kache & Seuring, 2017), limited prior work has explored in detail how such transformations lead to changes in the management of: (i) collecting, (ii) processing, and (iii) transferring information, between partners (Roßmann et al., 2018), nor what information asymmetry this may lead to. Developing a more detailed understanding of the degrees, types and forms of data-sharing taking place in inter-organisational relationships is crucial to support digital transformation. Second, prior studies offer very limited insights into how contractual and relational (i.e. trust, relational norms) governance mechanisms may be effectively used to support information collection, transformation and distribution in inter-organisational relationships (Kache & Seuring, 2017), and thus manage information asymmetry.

We therefore study how organisations manage information asymmetry that emerges in IORs as a result of digital transformation. More specifically, we draw on Organisational Information Processing Theory, OIPT (Galbraith, 1974), and conduct four in-depth case studies of public-private partnerships (PPPs) implementing disruptive technologies to answer the following research question: *In public-private collaborations undergoing digital transformation, how do contractual and relational governance mechanisms affect information asymmetry through the acquisition, transformation and subsequent dissemination of information?*

We contribute to extent work in two primary ways. First, building on OIPT, we draw out the various key activities, namely collection, sense-making and transferring information, when partnering organisations seek to address information asymmetry. While prior work has used OIPT in mainly intra-organisational settings, limited work has used the theory to explore inter-organisational information exchanges (exceptions include Bode et al., 2011; Dahlmann & Roehrich, 2020). Second, we contribute to supply chain governance literature by empirically studying the role of governance in IORs undergoing digital transformation. More specifically, we show how contractual and relational governance are deployed in IORs for acquisition, transformation and dissemination purposes, and to what effects. This is a vital area of future research as the effective management of inter-organisational relationships across the supply chain is paramount for organisations' survival, requiring governance mechanisms that support the need to mitigate information asymmetry.

The remainder of this paper is organised as follows. First, we review relevant literature on digital transformation, OIPT and IOR governance. Subsequently, we elaborate our research approach after which we turn to our findings. We then conclude and discuss scientific and managerial implications.

Theoretical background

Digital transformation, as enabled by the recent emergence of disruptive technologies, changes paradigms, principles and models in SCM (Ivanov et al., 2019). Various base technologies (i.e. the Internet of Things (IoT), cloud services, and big data and analytics)

enable a wide-range of front-end technologies along four dimensions: Smart Manufacturing (e.g. machine-to-machine communication), Smart Products (e.g. product's monitoring), Smart Supply Chains (e.g. digital platforms with SC partners), and Smart Working (e.g. remote monitoring and operations of production) (Frank et al., 2019). Potential applications are many, for example in forecasting and inventory management at manufacturers and retailers (Waller & Fawcett, 2013). Another area of application concerns maintenance, where disruptive technologies are important enablers for predictive or condition-based maintenance (Sakib & Wuest, 2018).

The large amounts of technical and commercial data generated by these technologies provide ample opportunities for organisations to improve their productivity, as well as more fundamentally to transform their business and processes not only internally, but also with external partners (Roßmann et al., 2018). However, this requires organisations to carry out information processing activities, such as acquiring data, transforming data into information, and communicating & storing information effectively (Rosado Feger, 2014).

OIPT (Bode et al, 2011; Galbraith, 1974) argues that organisations manage environmental uncertainty by deploying information-processing mechanisms that best address the amount and type of information asymmetry they are faced with. Information asymmetry is characterised as the absence of information (i.e. information uncertainty), or as the messiness or ambiguity of information (i.e. information equivocality). Information uncertainty may refer to a lack in quantity as well as quality of information needed to perform tasks (Galbraith, 1974; Zhao et al., 2011). The more uncertainty an organisation is exposed to, the more information needs to be gathered and processed to realise a given performance level (Bode et al., 2011). Equivocality, in turn, describes situations in which information is messy and ambiguous, leading to potentially conflicting interpretations and a lack of understanding (Daft & Lengel, 1986).Whereas collecting more data helps managers mitigate information uncertainty, equivocality requires managers' cognitive skills to make sense of the data, thus ordering and presenting information in a logical way. This is particularly true when the information required is ill structured, difficult to evaluate and requires more than one individual for their interpretation. (Daft & Lengel, 1986).

Information processing is hence considered essential to 'bridge disagreement and diversity' (Daft & Lengel, 1986) between two (or more) organisations that have different objectives and values as predominant, for example, in public-private relationships (Caldwell et al., 2017). Information processing complexity increases when a focal organisation's supply chain partners are involved, as is the case in outsourcing relationships. At the same time, the interactions between partnering organisations may be conducive to generate more information (which is further supported by digital technology), making effective information processing, as characterised by the three key stages of information gathering, interpreting and transferring, even more critical. Surprisingly, the majority of research adopts OIPT for intra-organisational issues (e.g. Turner & Makhija, 2012), making our insights into the application of OIPT to inter-organisational settings such as in focus in our research fairly limited. (Busse et al., 2017).

Moreover, research by Kache and Seuring (2017) indicated that governance, i.e. the orchestration of digitalisation-related efforts across dyads and the collaboration rules this calls for, ranks first on the list of supply chain-level digitalisation challenges (4.33 importance score on a 5-point Likert scale). However, extent work offers little understanding of the roles that contractual (i.e. legally binding agreements that specify roles and obligations of contracting parties; Lyons & Mehta, 1997) and relational (i.e. the strength of the social norms present in an exchange situation; Ferguson et al., 2005) mechanisms play in addressing information asymmetry during digital transformation.

Following the seminal work by Tushman and Nadler (1978, p. 617) who note that "different organisational structures have different capacities for effective information processing", we now consider contractual and relational governance mechanisms, and their capacity to address information asymmetry in inter-organisational relationships.

Contractual governance and its associated mechanisms influence the processing of information through a range of different elements, including rules, operating procedures, planning, and incentive systems (Lumineau, 2017). Contracts can stipulate information gathering by explicitly including control and coordination clauses that require information exchange (including type, frequency and quality) between contracting parties (Faems et al, 2008; Mayer & Argyres, 2004). These clauses can also include the clauses on the frequency of meetings between organisations' key decision makers (Mesquita & Brush, 2008; Susarla et al. 2010). Information exchange can furthermore be encouraged by issuing appropriate incentive schemes. In addition to the gathering of information, contracts influence the way information is interpreted and how organisations make sense of its importance (Daft & Weick, 1984). Coordination mechanisms may facilitate information processing by encouraging a cohesive interpretation of objectives (Puranam et al., 2006). Finally, contractual mechanisms influence the synthesis of information, that is, the ability to develop linkages and understand interconnections among different pieces of information, frequently using contracts as knowledge repositories reflecting on changes in the relationship (Mayer & Argyres, 2004; Zheng et al., 2008).

Relational governance and its mechanisms (i.e. trust, relational norms), in turn, may influence the processing of information through social processes (Heide & Miner, 1992; Poppo & Zenger, 2002). In the presence of trust, parties will be more likely to expend efforts into gathering information. A trusting culture in supply chains furthermore leads to higher levels of information exchange across parties (Kache & Seuring, 2017); Ghosh & Fedorowicz, 2008). Finally, the free flow of information under trust allows for enhanced synthesis of information. Relational norms refer to the shared expectations about the behaviours of partners involved in an IOR (Cannon et al., 2000; Heide & John, 1990), and imply a bilateral expectation that parties will proactively provide useful information to their partner in support of the ongoing relationship. Norms of information exchange, solidarity and participation (Heide & John, 1992) thus address behavioural expectations in ongoing, present-day relationships. Information exchange is the expectation that parties will freely and actively provide useful information, which leads partners to solicit and exchange private information often (Carson & John, 2013; Heide & John, 1992). Solidarity is a feeling of mutuality (Jap & Ganesan, 2000) which leads partners to treat problems that arise in a collaborative way. Consequently, both will feel the need for gathering and sharing relevant information. Finally, participation refers to bilateral expectations regarding decision-making and goal setting (Dwyer & Oh, 1988), based on joint analysis and interpretation of information.

Our in-depth, multiple case studies will shed light on the roles of both governance mechanisms in addressing information asymmetry during digital transformation.

Approach

We conducted in-depth, multiple case studies, because this allowed us to address the question of how contractual and relational governance mechanisms address information asymmetry in public-private relationships through the acquisition, transformation and subsequent dissemination of information as part of digital transformation. This method yielded multiple observations of complex contract design and relational governance challenges (Golden-Biddle & Locke, 2007).

We purposively sampled four inter-organisational exchange relationships that had implemented disruptive technologies, and that were characterised by information asymmetry between (semi-)public organisations and their private partners. These included established relationships with contractual and relational governance in place. Our four cases come from two (semi-)public organisations, and involve differing information processing challenges, i.e., differing levels of information uncertainty and equivocality. The research context is that of public bodies managing critical infrastructures (i.e. roads and waterways, and water management; railways) in the Netherlands. These public bodies have outsourced the maintenance of these infrastructures to private contractors. Disruptive technologies have been adopted for the purpose of enhanced asset management and maintenance. **Table 1** provides important details on the two (semi-) public organisations and the four cases, including interview evidence supporting our assessments of uncertainty and equivocality in the cases.

We put a great deal of effort into gathering reliable and objective data from our informants (Alvesson, 2003) and interviewed various stakeholders with different lengths of tenure in disparate hierarchical and functional roles, to access diverse perspectives that allowed us to triangulate data. This resulted in ten interviews at each organisation with asset managers/asset specialists and area managers (asset management perspective), configuration managers and data scientists (data perspective), and contract managers (outsourcing perspective). To minimise respondents' biases (Golden, 1992), we designed an interview protocol that we adapted to the characteristics of different informants and refined over time as the research progressed and theoretical constructs emerged. Overall, twenty hours of interview data was collected and transcribed. Data collection happened in real-time, i.e. during the ongoing public-private relationship (October 2018-December 2019). Moreover, 22 documents have been analysed (seventeen at Road and five at Rail) in total, including contracts, documents describing visions on smart maintenance, project documents, and official reports. We gathered data until we reached an in-depth understanding of the phenomena under investigation and new data collection did not provide any fresh and relevant information for the development of new insights (i.e. data saturation). The quality and rigour of the case studies was ensured by applying specific criteria and measures that address construct validity, internal validity, external validity, and reliability issues (Yin, 2013).

Data coding and analysis took place in parallel with data collection following recommendations by Barratt et al. (2011) and Miles and Huberman (1994). Data was coded in Atlas.ti using a list of provisional categories (i.e. information acquisition/ transformation/dissemination, and contractual and relational governance), but increasingly included additional themes and codes as they emerged from the interviews (e.g. "organisational readiness" and "management support"). Open codes (e.g. "data requirements", "bonus", "penalty", and "contractor behaviour") were assigned to excerpts of the interview transcripts and contracts. Next, these were grouped into higher-order categories (e.g. "contract design" and "incentive schemes") using axial coding procedures. Overall, data analysis was an iterative process with codes being refined by moving back and forth between data, the analytical framework and the cross-case analysis.

Table 1 - Case Characteristics

	Road Governmental agency responsible for main roads and waterways in the Netherlands.		**Rail** Private limited liability organisation (fully government-owned) responsible for the railways in the Netherlands.	
	Case E	**Case Y**	**Case S**	**Case N**
Contractor Details	Consortium consisting of (1) a large international contractor specialised in electro-technical installations and (2) an equally large international contractor specialised in construction.	Consortium consisting of (1) a larger international contractor specialised in electro-technical installations and (2) a smaller national contractor specialised in construction.	Large international contractor specialised in construction and maintenance of railroad systems.	Medium-sized national contractor specialised in construction and maintenance of railroad systems.
Contract - Scope	Includes maintenance of an important waterway corridor connecting the eastern part of the Netherlands with Germany.	Includes maintenance of an important waterway corridor connecting inland waterways with the North Sea.	Includes maintenance of a major railway connection between two large cities in the middle and southern part of the Netherlands.	Includes the maintenance of the railway connections to the east of the most central train station in the Netherlands.
- Type	Locally customised performance-based contract.	Locally customised contract with performance & behaviour aspects.	Centrally led performance-based contract.	Centrally led performance-based contract.
- Duration	5 years (option for two 1-year extensions).		5 years (with extension option if new public tender is delayed).	
Relationship Length	No prior relationship with either contractor.		No prior relationship.	Second consecutive contract with this contractor.
Technologies	Sensors mounted to critical (moving) parts of sluice doors.		Sensors mounted to railroad switches.	
Information Sources	▪ Sensors. ▪ Contractor's inspection reports. ▪ Road's operating systems for moving assets (such as sluices). ▪ Road and contractor's asset management systems.		▪ Sensors. ▪ Dedicated inspection trains (equipped with cameras and sensors). ▪ Contractor's inspection reports. ▪ Rail's asset management system.	
Uncertainty	**High** as data and information is insufficient or of low quality: "*I hope that we can indicate the information needs we have to the* [IT dept.] *and that they deliver this information*" – Asset Manager (E). "*In the future, we need to be able to look back in the analysis and ensure that it can provide us with enough information, and not just things like 'finished', 'button pressed', etc.*" – Contract Manager (Y).		**Low** as data and information is controlled by Rail: "*We receive data from inspection trains from other departments, for example*" – Area Manager (S). "*So that is a system where we just share the data, because they see everything in it, but I see that too*" – Assistant Area Manager (N).	
Equivocality	**Low** due to more intensive collaboration with contractors: "*What I would also like to see is that market parties realise that by jointly working on this type of information, they can also organise the maintenance process much more efficiently*" – Asset Manager (E). "*So what do they need to do it* [maintenance] *well and what do we need to manage it well? Well that is how you work together. So it should no longer be a blaming game*" – Configuration Manager (Y)		**High** due to issues with handling large amounts of data: "*It* [current state of rail tracks] *is all good and we are doing pretty well in terms of failures. But I also don't have everything in sight and neither do the inspectors*" – Regional Contract Manager (S). "*Well there has been a lot of budget cuts and there are now only 1 or 2 people in our region. I believe there is only one left. He has to do it all alone*" – Assistant Area Manager (N).	

Findings

Hereafter, we highlight the main findings for the four cases. As each set of cases involves the same asset owner, we opt for descriptions at the level of the case company, weaving together the findings of both cases. This reduces repetition and allows us to elaborate on similarities and important differences. In the discussion, we highlight how and to what extent the two case companies, in each of their cases, use contractual and relational governance mechanisms to organise the acquisition, transformation and dissemination of information. We then discuss these findings in relation to information uncertainty and equivocality. Key observations and corresponding quotes are listed in **Table 2**.

Regarding information acquisition, Road's contracts clearly stipulate that they own the data, and that the contractor should share any data they collect (related to maintenance times, materials used, etc.) with fixed intervals. Incentive schemes have been put in place, including penalties for not sharing data. However, evidence suggests efforts to share data outweigh the penalties by far, causing contractors to accept penalties instead. The (in-) compatibility of systems also contributes to acquisition problems. Due to configurational differences, information entered in the contractor's system cannot be directly transferred to Road's system without losing part of it. Overall, the contract seems to need more specific provisions regarding information sharing. Furthermore, Road feels that the contractors are not fully open. This stems from the past when Road followed a 'market unless' strategy, leaving everything related to the maintenance of assets to market parties. However, recently Road, learned this led to a hollowed out maintenance organisation and loss of control over its assets. Road therefore changed to a 'together with' strategy, in which they pursue the optimisation of asset maintenance together with contractors. As such, Road increasingly relies on relational mechanisms aimed at joint goal setting, and requiring intensive information exchange. Nevertheless, it still seems to be influenced by its traditional tendency to develop relationships with contractors that are more transactional in nature making it difficult to achieve relationships that are more open.

Road is not fully able to transform data all by itself. This is due to a technical shortcoming since its system does not support the 3D format provided by its contractors. The loss of knowledge regarding maintenance during the 'market unless' period further complicates the ability of Road to transform information. To address this issue, Road has started to develop a vision to help identify exact information needs of its departments. For this, they tap into the expertise of their contractors as well, and both parties aim to jointly determine what transformations need to be performed and by whom.

The dissemination of information also benefits from the shift to focus on collaborating with market parties. Road now acknowledges that combining information from both organisations can actually have complementary effects. This collaborative focus drives Road to develop stronger relationships with its contractors, and therefore more actively communicates with its contractors to disseminate information. This includes information about failure profiles of assets and the use of assets by end customers. A lack of flexibility in the current contracts, however, makes it rather difficult for Road to incorporate innovations. Current contracts are rather descriptive and, once signed, additions (including innovations) to the contracts are not allowed. Therefore, innovations often have to be put on hold until the current contract period has ended.

At Rail, there is a strong focus on collecting data internally. As part of the data can only be collected by its maintenance contractors, Rail's contracts stipulate that contractors need to share data either on fixed intervals (e.g. monthly inspection reports regarding the state of assets) or upon request (e.g. if an unexpected failure occurred to determine to what extent this could have been prevented by the contractor). However, our evidence suggests that Rail does not monitor the contractual requirements consistently due to

internal capacity constraints with respect to its workforce. Contractors seem to notice quite quickly what is and what is not checked by Rail's employees, and tend to share only those pieces of data that are under scrutiny. On top of that, contractors seem to be hesitant to share data with Rail due to the transactional nature of the relationship. Contractors seem to feel that the data they share is mainly used to evaluate their performance, which leads them to only share data if needed (Rail actively checks whether it is received) or if the data is favourable for the contractor (the data that is not actively checked by Rail).

Rail aims to perform the majority of the information transformation activities internally. However, it seems that internal as well as external challenges influence the transformation. Internally, due to several past budget cuts, Rail is now short on staff that is trained to transform the data they have. Rail also experiences challenges with data that is incomplete or only received after explicit requests to contractors, due to insufficient monitoring and enforcement of information sharing clauses. Additionally, contractors perform a small part of the transformation, as they are contractually obliged by Rail to prove their performance. Rail's monthly evaluation of the contractors' maintenance performance is partially based on the information provided by the contractors in their own evaluation reports in which the contractors use maintenance data to substantiate claims.

Rail seems to focus on controlling the dissemination of information through contractual agreements. Rail's contracts actually stipulate which organisation should report what information, and what the other partner should do with it. Rail seems to invest less in relational governance to help with the dissemination of information. This seems partially motivated by the fear of being too open, thereby revealing evidence that neither parties is fully compliant with the agreements made in the contracts. This in turn may lead to disputes between Rail and its contractors, but also with other potential contractors that did not win one of the contracts.

Looking at how Road manages information asymmetry, the 'messiness' of its data and information seems to be managed rather well (i.e. low equivocality). After years of leaving maintenance completely to their contractors, Road now actively collaborates with its contractors to regain knowledge about their assets. This helps Road to understand its data and information needs, and how to use it, better. However, Road faces rather high levels of information uncertainty. Uncertainty is primarily present during the acquisition of data. Even though the contracts stipulate that contractors must share data, the current incentive schemes seem to act as a barrier. Uncertainty is also present during data transformation due to internal struggles (determining the exact information needs) and technical challenges (related to the quality of data provided by contractors). While an open relationship seems to lower uncertainty to some extent, at Road, uncertainty is largely due to the current contractual mechanisms in place. The contracts do not possess efficient incentive schemes to motivate data sharing, nor do they possess clear agreements with respect to the (technical) specifications of what data must be shared and how.

Rail manages to lower its information uncertainty by focusing on contractual control. Through its current contractual governance mechanisms, Rail clearly described where the data should come from, who should transform what data, and finally who should receive the transformed information in the end. Although uncertainty is low, Rail is still confronted with incomplete or missing data, due to inconsistency in monitoring to extent to which contractors meet contractual requirements with respect to data and enforcing it. Using contracts to reduce the messiness of information (i.e. equivocality) as well seems to be only marginally effective at Rail. For example, although Rail contractually obliged its contractors to perform some information transformation, contractors tend to do so only when it is explicitly requested by Rail. There is no open relationship just yet, and proactive information sharing and mutual learning opportunities are lacking.

Table 2 - Influence of contractual and relational governance on information processing activities.

	Contractual Governance	**Relational Governance**
Acquisition	Contracts stipulate that Road owns the data; contractors should share: "[…] *we have one main objective. We call it 'making the ABC' of the area. Improve the quality of data*" – Asset Manager 2 (E). "*The Contractor must deliver Area data once maintenance is completed, so that* [Road] *can perform proper management of its Area*" – Contract Document (Y) Incentive schemes not effective for getting all the data: "*They do get a penalty, but that is sometimes much less than what they can save if they do nothing*" – Asset Specialist (Y).	Contractors seem to be hesitant to share all data related to performed maintenance activities: "*But they do not put all their cards on the table. It is true.*" – Configuration Manager (Y). Through opening up, Road aims to improve communication and mutual understanding: "*And I think that the other part is mainly a matter of creating good connections and agreeing on what you are going to do*" – Data Scientist (E).
	Rail's contracts stipulate that contractors share data upon request: "*If one of our inspectors has been outside and comes back with the message 'that doesn't look good', we* [Rail] *can request all their inspection reports*" – Assistant Area Manager (S). Contract enforcement has been deteriorating: "*Only enforcing it, that needs to tightened, because the department that enforced it has been halved"* – Assistant Area Manager (N).	Contractors seem to be hesitant to be fully open to Rail: "*But they* [contractor] *also see things outside that we* [Rail] *have not seen that they are not going to report. That is just how it works*" – Regional Contract Manager (S).
Transformation	Missing information and misaligned contractual agreements hamper transformation by Road: "*The information is described in the description field, but that is not in the form of data. So if you want to analyse that, you have to search in the text boxes and have to organise that first* " – Asset Manager (Y) "The b*iggest problem is that local information needs and* [general] *contract requirements do not match. If you have specified your needs, the contract should accommodate these*" – Config. Manager (Y)	Road seeks collaboration to unlock information: "*What I would also like to see is that market parties realise that by jointly working on this type of information, they can also organise maintenance process much more efficiently*" – Asset Manager 1 (E). "*That is our pilot. That they process all malfunctions directly in our system"* – Asset Manager (Y).
	Rail requires some transformed information from contractors: "*They often have to demonstrate on a monthly basis, by means of data, that the requirements we set in the contract, that they meet them*" – Area Manager (N).	Rails contractors tend to avoid doing too much: "*Then the contractor's way of working: I don't deliver this, I don't deliver that and that. I'll see if I hear something* [from Rail]"- Regional Contract Manager (N).
Dissemination	Road wishes to share information with external parties other than their current contractors; current contract does not facilitate that: "*But we want to be able to pass that data on to the next contractor*" – Asset Manager 1 (E).	Road seeks to enhance current relationships through sharing information with their partners: "*We are not only knowledge seekers, but also knowledge bearers. So we can also return knowledge to them*" – Configuration Manager (Y).
	Rail specifies clauses with respect to data usage: "*There is a certain clause in the PBC contract that clearly states that this and this must be reported by* [contractor] *to* [Rail], *and then* [Rail] *must act on it*" – Assistant Area Manager (N).	Transparency may lead non-compliance with tender regulations leading Rail and its contractors to refrain from sharing all information: "*Transparency is not desirable. Maybe not from* [Rail] *either, but I am not sure about this*" – Regional Contract Manager (N).

Conclusion

Disruptive ICT-based technologies driving the digital transformation of IORs force organisations to reconsider their information processing activities. Limited attention has been paid to the roles that contractual and relational governance mechanisms play in organising information processing activities in IORs undergoing digital transformation. Our in-depth multiple case studies provide several insights into how mechanisms of contractual and relational governance are deployed to govern the three key activities identified by OIPT, and to manage information asymmetry.

First, while information gathering and sharing activities can be made explicit and can be stipulated in contracts, transformation and dissemination seem to make a larger appeal to informal safeguards such as trust. Our cases highlighted the existence of specific contractual clauses related to information gathering and sharing, but that these clauses could be more specific (e.g. format, level of detail, etc.) and that incentive schemes needed adjustment if information gathering and sharing was to arrive at the desired levels. In contrast, transformation activities need a clear perspective from both partners on what kind of information is required, for what purpose, and by whom. This requires more intensive collaboration, in the form of joint goal setting and decision-making (Dwyer & Oh, 1988), which may successfully be achieved by developing relational norms. Trust also plays and important role here, as parties need some certainty that their openness will not be taken advantage of by the other partner (Birkel & Hartmann, 2019).

Secondly, we found that due to its focus on information gathering and transformation, contractual governance seems most effective in reducing information uncertainty. In contrast, relational governance seems most fruitful to tackle equivocality, as the exchange of information is part of joint problem-solving, and decision making helps to develop the cognitive skills of individual decision makers and information structuring and evaluation processes. This suggests the need for different governance approaches depending on the nature and level of information asymmetry between collaborating organisations. A one-size-fits-all approach will not bring the desired results. Consequently, organisations may simultaneously address information uncertainty and equivocality by deploying contractual and relational governance mechanisms respectively. Additionally, findings show that organisations do not have to target uncertainty and equivocality simultaneously to lower information asymmetry, nor have to address these in a specific order.

For managers, this research offers insights into how organisational information-processing activities can be organised in inter-organisational dyads that are confronted with increasing amounts of data resulting from the adoption of disruptive technologies. Additionally, it provides insights in the way contractual as well as relational governance help to coordinate the three information-processing activities within relationships.

Specific limitations aside, this research has shown how contractual and relational governance may be deployed in IORs for acquisition, transformation and dissemination purposes, and to what effects. As such, we offer a first important step in a vital research area, i.e. how governance mechanisms may support the digital transformation of IORs.

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